Available online at www.sciencedirect.com

ScienceDirect

Procedia Social and Behavioral Sciences 1 (2009) 2191–2196

Procedia
Social and Behavioral Sciences

World Conference on Educational Sciences 2009

An investigation into the relationship between the understanding and use of mathematical language and achievement in mathematics at the Foundation Stage

Gill Woods*

University of Wolverhampton, Walsall, WS1 2BD, U.K.

Received October 6, 2008; revised December 14, 2008; accepted January 4, 2009

Abstract

This paper describes an investigation into whether there is a link between mathematical achievement in the Foundation Stage and the children's use and understanding of number language. The data gathered suggested that there does not appear to be a clear link. From the results obtained it would appear that the relationship between achievement and language becomes stronger as the children reach the end of the Foundation Stage and move into KS1.Although the younger children often performed at quite similar levels, the achievement of the Reception children was quite different with the socially advantaged children out-performing their peers. Some implications for classroom practice are also highlighted.

Keywords: Mathematical Language; Foundation Stage; Achievement; Number Concepts.

1. Introduction

This piece of research aimed to identify if there is a link between mathematical language (receptive and spoken) and achievement in mathematics in the Foundation Stage. I conducted the research in 2 schools in different socio-economic areas because I wanted to discover whether the possible link is related to this issue.
The objectives of this research were to:

- establish whether there was a link between receptive language and mathematical achievement
- establish whether there was a link between mathematical achievement and the language children articulate themselves
- investigate whether staff perceive children as being more able in mathematics because they are articulate, rather than basing their judgement on their mathematical ability

E-mail address: G.Woods@wlv.ac.uk

1877-0428
doi:10.1016/j.sbspro.2009.01.385

- discover if such a link between language and achievement existed, whether this changed as the children move through the Foundation Stage. I wanted to establish if it became more or less important. I therefore studied children in Early Foundation Stage i.e. Nursery and Late Foundation Stage i.e. Reception.

My key questions were:
- What is the children's current understanding of number language?
- What is the children's current use of number language?
- What is the children's current achievement in number and calculating?
- Is age an important factor when considering language and achievement?
- Do socio-economic factors have any bearing upon this issue?
- Do staffs perceive children as being more able in number because they are articulate?

2. Body

Methodology

2.1 Size and characteristics of sample

I conducted the research in 2 schools in different socio-economic areas. School A was a one form entry school in an area of severe deprivation. High mathematical achievement was not a feature of this school's history and despite considerable support from external bodies and a number of initiatives it remained low. School B was a two-form entry first school in a fairly privileged area. It was awarded Beacon status because of the high standards achieved, particularly in Literacy. This school in contrast to School A had a history of high achievement within mathematics. I chose to focus on a group of 4 mixed ability children in each age group per school i.e. 16 children in total.

2.2 Research methods selected

I was keen to attempt methodological triangulation as it would enable me to collect data from a variety of sources and thus gain as much information as possible. Edwards (2001) points out that triangulation helps to produce rich data that attempts to reduce some aspects of bias. I decided to opt for both non-participant and participant observation as I felt it would help me to address the first 3 key questions. Both types of observation were conducted within the classroom/nursery setting. This was a deliberate decision as it was felt both by staff and me that the children would be more likely to behave normally than if they were in an unfamiliar setting. It was a direct method where I could watch and listen to the children. This data could be complemented by other methods. These other methods, conducting interviews with key members of staff and distributing questionnaires to other staff, were also chosen to help me address the latter 3 questions. I chose to use a variety of different methods as I was aiming to achieve a valid and reliable piece of research (Robson 2002).

2.3 What is the children's current achievement in number and calculating?

From observations and consultation of staff it is apparent that 9 out of the 16 children were either achieving at an appropriate level or exceeding expectations. Out of the remaining 7 children one of these was clearly linked to receptive language difficulties while the others had both difficulties in number and language and found a number of other curriculum areas challenging. This would seem to be in line with the research conducted by Siegel where children who had difficulties with language also had difficulties in counting with 1 to 1 correspondence and conserving number. (Siegel cited in Donlan 1998) Fazio also noted that these children had difficulties counting by rote too. (Fazio cited in Donlan 1998)

2.4 What is the children's current understanding of number language?

Nine out of the 16 children had an age-appropriate understanding of number terminology. The class teachers' thoughts concerning understanding of vocabulary reflected very similar results to those I had observed in the settings.

2.5 What is the children's current use of number language?

The language used related to counting, comparing and ordering numbers and adding and subtracting. The majority of the children used mathematical vocabulary of their own volition but it was not always related to number. The Class Teachers suggested that seven out of the 16 children rarely used number language. From my observations 2 of this group did use some number vocabulary but it was limited in range and might explain the differences in opinion. Some of the children observed made use of number vocabulary which was more appropriate for Y1.

2.6 Is age an important factor when considering language and achievement?

Looking at the difficulties the Nursery children had in the participant observation activities I would suggest that most of these were due to mathematical difficulties such as not understanding the cardinality aspect of number. The problems which were related to language as in the activities relating to 'before', 'less' and 'smaller number' also I believe stemmed from mathematical difficulties as even when I modelled what to do using hardly any language, the children were still unable to complete the task.

Examining the difficulties the Reception children experienced I would also suggest that some of these stemmed from a mathematical source such as the counting without touching and understanding about counting on. However, some of the difficulties did stem from a language source as once certain tasks had been rephrased, the children were able to access them.

I would suggest from this evidence that the link between achievement and understanding of mathematical language becomes more important as the child moves through the Foundation Stage. This is in line with Souviney's view cited in Clarkson (1992) who also concluded that the importance of language ability increased as the children grew older. This was also the view of the majority of staff who completed the questionnaires.

From the interview data it would appear that the link between achievement and use of mathematical language becomes more important as the child moves through the Foundation Stage. This could be because Reception children's receptive language is more developed and thus the child can understand a different explanation. I would also suggest that by Reception most children have developed some mathematical skills and may not be able to demonstrate achievement because of a lack of understanding of certain mathematical terms. However the data from the questionnaires suggests that this is not so clear-cut with exactly half of the staff stating that this was the case whilst their colleagues suggested that the use of language remains important throughout. Clearly practitioners place great importance on the children's use of number language.

Do socio-economic factors have any bearing upon this issue?

Achievement

While the achievement of Nursery children in School A and School B often appeared to be very similar, the achievement of the Reception children was quite different with some of School B's children outperforming their peers markedly. This is in line with the research conducted by Ellerton and Clements (1991) where they concluded that children from more advantaged backgrounds developed more rapidly than their socio-economically deprived peers. The highest achievers in School B's Reception were able to work with much larger numbers than those in School A and used a greater number of strategies. School A's children were less accurate than their peers in School B. I do not believe this slower progress to be insufficient challenge in School A as the children were offered work that was appropriately matched to their current levels of understanding. Each setting devoted approximately the same amount of time to mathematical activities. I think this would be worthy of further investigation.

Language – understanding

The most obvious difference between the schools was in the way the children reacted to the terms 'less' and 'before'. More children in School A understood these and two used 'less' themselves. Many of the children in School B asked me for further clarification for 'less', suggesting that this term may not be used so frequently in the classroom.

Language – use

When children in School B used mathematical language it was always in the correct context. The two children who used it incorrectly came from School A – 1 in Nursery and 1 in Reception. This would seem to indicate that these children are still experimenting with some of the language. The 2 more reticent children came from the Reception age group – one from each school. The child in School B spoke little to adults, although was more willing to talk to his peers. This may have been because he was conscious of his inability to express himself articulately. The other Reception child was quite willing to talk but chose not to use any mathematical vocabulary of her own volition. She would however use it if the task required her to do so. This seems to indicate a lack of confidence specifically related to mathematical vocabulary rather than an overall unwillingness to talk.

Do staff perceive children as being more able in number because they are articulate?

The Nursery staff who were interviewed did not feel this was an issue but Reception staff did believe that the child's use of number language was of vital importance for numerical achievement during the latter part of the Foundation Stage. Because staff hold this opinion children may be perceived as being more able than their less articulate peers even if this is not the case. From the questionnaire data it would appear that staff could be led to believe the children were more capable in the calculating strand because they could explain what they had done. It did not appear to be the case in the counting strand.

3. Conclusion

Implications for Teaching

From the good practice I have observed in the 2 settings I believe the following points can be highlighted:

3.1 Use of a wide range of teaching strategies, not solely reliant on verbal language

There may be other children like the child in School B's Reception who had receptive language difficulties who could experience success with the minimal of verbal instructions. This is not to say that number language should be avoided but should be used and then reinforced with a range of teaching strategies. I suggest modelling and practical demonstrations should accompany verbal explanations. The use of apparatus such as a variety of counting equipment and number lines could prove very useful here.

3.2 Use of non-verbal assessment techniques

Likewise when children are assessed they need to be able to demonstrate their numerical ability rather than their receptive/expressive language skills. Activities that make as little use of language as possible and practical demonstrations would be appropriate methods. Assessments need to allow the children to demonstrate what they know and staff should not have a ceiling on their expectations. Where possible practitioners should observe children in self-initiated activities as this is often a time when children can perform at their highest level (Pound 1999). When practitioners do design specific tasks they should be as open-ended as possible to enable children to perform to their highest ability.

3.3 *Whole class exposure to larger numbers*

School B's Reception class were exposed to larger numbers and some children were clearly benefiting from it. It appears that if a small number of children fully understand these numbers they have a beneficial effect on the rest of the class. This adds to Munn's (1997) debate on the development of counting. She discussed whether the principles of counting developed first or counting ability was first. She stated if counting ability preceded the understanding of principles then experience of larger numbers, whether understood or not, would aid development. I would suggest that this may be the case but further evidence needs to be gathered to make a certain claim.

3.4 Modelling of correct language by practitioners

The practitioners I observed used number language in informal situations as well as in formal teaching activities. The children were thus hearing the vocabulary used in the correct context, which they could copy, and use for themselves. For example I observed a member of staff playing with a group of children in the florist's shop. She was able to use the language of position, size and quantity, which some of the children were later heard to use in their own independent play.

Is there a relationship between the understanding and use of mathematical language and achievement in mathematics at the Foundation Stage?

It does not appear to be clear-cut. Some of the group were able to demonstrate achievement despite having receptive or expressive language difficulties. Other children had both mathematical as well as language difficulties and it would be interesting to track the mathematical progress of these children, as their language develops, to establish more clearly whether and how these difficulties are linked.

The answer to this question is also dependent on the practitioners that assess the children. If children are only allowed to demonstrate achievement through the medium of language then lack of progress here will hinder the children's opportunity to shine.

The DfES' revised framework (2006) places great emphasis on calculation and it is viewed as key to excelling in mathematics. I would suggest that the relationship between language and achievement in calculation becomes stronger as the children reach the end of the Foundation Stage and move into KS1 by the nature of the curriculum. Firstly there is an emphasis on the use of mental methods. The children are required to calculate in their heads using a variety of methods. To do this a child has to internally talk through what they are doing which clearly involves the use of language. I would argue that the more articulate a child is the easier he will be able to do this, which will then have a beneficial effect on his mental calculations. Secondly the revised framework (2006) introduces more calculation methods as the children progress through KS1. This naturally involves more exposition from the teacher and unless the practitioners use additional resources the child with receptive language difficulties will experience difficulties here too. Thirdly, there is a greater demand for explanations by the child of how they solved a problem. This would have repercussions for the child who has expressive language difficulties. These children need to be supported in their explanations and be encouraged to supplement their verbalisations with jottings or apparatus to enable staff to make a more accurate judgement of their mathematical achievement. I thus believe that the older the child becomes the greater the importance his understanding and use of number language is to his achievement in calculation and is thus key to achievement in numeracy overall.

4. Acknowledgements

I would like to thank the staff and children of the 2 schools who participated in this research. Without their willing participation this research would not have been possible.

5. References

Clarkson P. (1992) Language and mathematics: a comparison of bi-lingual and mono-lingual students of mathematics Educational Studies in Mathematics 23 pp.417-429

DfES (2006) Revised Numeracy Framework CSO

Donlan C. (1998) in (Ed.) Donlan C The Development of Mathematical Skills. pp.151-170 Hove: Psychology Press

Edwards A. (2001) Qualitative designs and analysis in Doing Early Childhood Research International Perspectives on Theory and Practice (2001) MacNaughton G, Rolfe S. & Siraj-Blatchford I. eds OUP Buckingham

Ellerton N.F. and Clements M.A. (1991) Mathematics in Language: a review of language factors in mathematics learning Deakin University Press

Munn P. (1997) in Thompson I. (eds) Teaching and learning early number pp.9-19 Buckingham:OUP

Pound L. (1999) Supporting Mathematical Development in the Early Years Buckingham: OUP

Robson, C. (2002) Real World Research (2nd Edition) Blackwell, Oxford